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**Lineman**

RURAL ELECTRIFICATION ADMINISTRATION - U. S. DEPARTMENT OF AGRICULTURE



## DON'T UNDERESTIMATE LOW VOLTAGE



REA Administrator Claude R. Wickard confers with Chairman D. B. Bidle at opening of annual Job Training and Safety Conference November 17.

## HILL SUCCEEDS FLEMING AS LABOR-SAFETY HEAD

Ralph A. C. Hill has succeeded D. A. Fleming as head of REA's Labor Relations and Safety Section. Mr. Fleming resigned to enter private business August 1.

Mr. Hill is well qualified for his new duties. He has had wide experience in this field in both private industry and government, part of which was in connection with farm co-operatives in the far West.

## Experiments Show Current Human Body Can Withstand

Amperes are the determining factors in electric shock. In other words it is the amount of current which kills, and not the voltage. But voltage is important too, because the amount of current which will flow is determined by dividing the voltage by the resistance (Ohm's law).

Experiments have been performed which give a fair idea of the amount of current the body can stand without harm and the current values beyond which it is unsafe to subject the human body. Since no experiments with unsafe values can be performed on humans the data is obtained from animal experiments, criminal electrocutions, and known electric shock accident facts.

The two following accident reports give graphic evidence as to why low voltage should not be underestimated.

A crew of men was converting a single-phase line to V-phase beginning at pole A and extending beyond pole B. A 120-volt secondary was on poles A, B, and C. To frame the poles B and C for the V-phase conversion, the secondary underbuild was de-energized and the primary conductor killed and grounded.

As soon as poles B and C were framed the underbuild was energized to provide service and the work continued beyond pole C. Just before quitting time the dead primary was put in shape so that it could be energized for the night. A member of the crew was sent up pole B to remove the ground. This man was cautioned that the bare secondary was hot. He

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## 120 CAN BE DEADLY

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From time to time, details of fatal low voltage electric shock accidents have appeared in THE LINEMAN. From the comment we have received about these accidents it is plain that few people understand the hazards of 120 - 240 volt electric shock.

Are we so used to handling this voltage in our homes that we have come to regard it as 'only 120 volts' - something that even children can play with safely? Or is it that we do not know what the conditions are that will make low voltage shock deadly?

Buried in the columns of our newspapers occasionally short articles appear which read like this 'Baby with wet pants sits on light cord and is killed when it touches radiator'; 'Naval electrician's mate found dead in basement; wiring a water pump'. 'Patient in hospital rolls over on heating pad, perspiration-soaked pajamas contact bare places in cord. Patient dies, unable to ask nurse for help'. 'Plumber found dead under house; was dragging defective extension cord with him and contacted bare wire'. 'Child electrocuted in bath tub when it reached out to adjust portable electric heater - a bare wire was in contact with heater frame'.

Surely the public, in the use of home appliances, and the men who operate and maintain electrical lines would take greater precaution in the use of 120 volt current if they knew what hazards were involved.

Electricity is no different from any other necessity of life. Water, without which we cannot live, is dangerous under certain conditions. Fire is equally essential yet, uncontrolled, it is a destroyer of life and property. Even the sun takes its toll of those who disregard the few simple precautions, which time has proved necessary.

Elsewhere in the LINEMAN is an article telling briefly why 120 volts under certain conditions may be as deadly as 7200.

## The Lineman Tours The States

John F. Ingram succeeds E. L. Plowden as State Supervisor of Trade and Industrial Education in Alabama. Mr Plowden resigned to continue his studies at Columbia University. Mr. Harris, head of Public Training, and the Alabama Advisory Committee, plan to add the second Training and Safety supervisor soon.

The Arkansas Job Training and Safety Program was launched November 1. An Advisory Committee consisting of: H. C. Knappenberger, Manager; H. E. Penticost, Manager; E. H. Looney, Manager; Otis Farrer, District Supervisor, State Department of Education has been selected to guide the program. The cooperating agency is the State Dept. of Trade and Industrial Education, headed by J. Marion Adams.

Florida plans to get its Job Training and Safety Program in operation in December. REA expects a very fine program in this State because of the 100% cooperation among the managers and board presidents. This cooperative spirit, coupled with a very aggressive State Department of Vocational Education, headed by Colin English and H. F. Hinton, should go places.

Missouri Job Training and Safety Program held a foremen's Training Conference, November 7 and 8, at Columbia, Mo.

Texas held its first annual Training and Safety Conference in Austin, October 3. The Training and Safety Program is made possible by three cooperating agencies: Texas Rural Electric Cooperatives, State Board of Vocational Education, and the A and M College of Texas.

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Frank H. La Master, former REA Safety Engineer, has returned to the Safety Unit to take over the duties of William Rushlow. Mr. Rushlow has transferred back to the Technical Standards Division.

# LITTLE KNOWN FACTS ABOUT ELECTRIC SHOCK

The following data is considered as reasonably accurate despite the difficulty of obtaining direct results from human subjects:

HUMAN RESISTANCE TO ELECTRICAL CURRENT

Type of Resistance	Resistance Values
Dry Skin	100,000 to 600,000 Ohms
Wet Skin	1,000 Ohms
Internal body	
Hand to foot	400 to 600 Ohms
Ear to Ear	about 100 Ohms

From the above table it may be seen that an electrical current of eight one-thousandths of an ampere can be fatal. In fact, early operation of the electric chair was effective with a current of eight one-thousandths of an ampere and pressure at somewhat more than 1000 volts.

Let us suppose that a lineman with clothes wet from perspiration contacts a 120-volt secondary line and is in contact with a good ground. Assume a wet skin resistance of 1000 Ohms and the internal resistance of 500 Ohms, or a total resistance of 1500 Ohms. By Ohm's law we find that 120 Divided by 1500 gives a

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apparently assumed that since he was removing the ground from a dead primary, the job could be done safely with rubber gloves. He had on the rubber gloves at the time he was killed.

To remove a live-line clamp with the hands it is necessary to climb high on the pole. This position placed the man in a situation with his feet in the underbuild, which was bare. While attempting to safety off, his foot apparently contacted the 120-volt underbuild. Hearing a shout from the pole top, a crew member looked up to find the victim standing rigid in his hooks, unable to move. The next instant the man fell backward to the ground. He fell on his head and it was later disclosed that his neck was broken in the fall. Artificial respiration failed to revive the man.

## The Second Accident

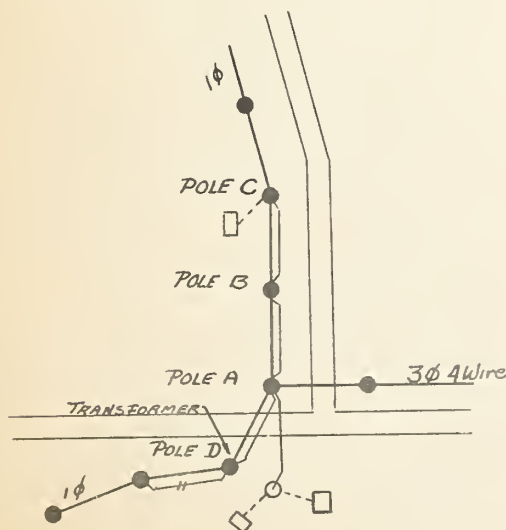
A crew of men were installing service wires. The weather was hot and they were wet with perspiration when they knocked off for lunch. The first job after lunch was to replace a #8 two-wire service with 3 #6 wires.

The underbuild which ran along the road was energized by a 3KV transformer several poles away. When work was started in changing out the two-wire service, one of the crew suggested that the transformer be de-energized. This was overruled as unnecessary.

The victim climbed the primary pole with his rubber gloves on and disconnected the two service wires. He then installed the third service clevice. To do this job he had apparently removed his rubber gloves and put a leather glove on his left hand leaving the right hand bare. His position on the pole was in the quadrant halfway between the service wires and the underbuild. His height on the pole was such that the bare underbuild was level with his hips.

The neutral service drop had been sent up and the ground man was preparing to send up the second wire when he heard the victim groan. The victim was standing rigid in his hooks with his right hip against the bare underbuild. He groaned again and his body slumped but remained upright. At this time his body pulled away from the underbuild.

The victim was lowered to the ground and artificial respiration applied for several hours, to no avail. Electrical burns were found on the right hip just above the belt and on top of the right foot.



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current of 80 milliamperes. From our table it is found that this current value is just under the fibrillation value. Also muscular control is lost and he cannot break the contact. As the contact is continued the skin resistance is reduced. If the skin is punctured, the skin resistance may then be disregarded to a large extent. For all practical purposes the total body resistance may now be in the neighborhood of 600 Ohms if it is a hand and foot contact. (The resistance would be less if the contact points were closer together.) As soon as the skin is punctured the current flowing through the victim's body would be 120 divided by 600 or 200 milliamperes. From our table we find that this current value causes ventricular fibrillation. If this contact lasts as long as 3 seconds, it is almost certain death. Suppose that the resistance factors were not as good as in the above example and the body resistance was doubled, or 1200 Ohms. 120 divided by 1200 gives 100 milliamperes. From our table we find that this is still within the current value which causes ventricular fibrillation and certain death.

Current is the killing factor in electrical shock. Voltage is important only in that it determines how much current will flow through a given body resistance. The current necessary to operate a 10-watt light bulb is eight to ten times more current than the amount that would kill a lineman. A pressure of 120 volts is enough to cause a current to flow which is many times greater than that necessary to kill. Currents of 100 to 200 milliamps cause a fatal heart condition known as ventricular fibrillation for which no remedy is known. Three cooperative linemen have been killed by 120 volt shock this year. Artificial respiration was ineffective in reviving them. We do not recall a single low voltage shock victim in the last 3 years who was resuscitated. This is in line with other observations. It is a generally accepted fact that fewer low voltage shock victims can be revived than those receiving shocks of 1000 volts or more.

The December issue of THE LINEMAN will continue with a discussion of high voltage shock. The third and concluding article in this series, to be published in the January 1948 issue, will contain a list of source material used in the series.

SAFE CURRENT VALUES	Current Values *	
	CAUSES NO SENSATION - NOT FELT	1 Milliamperes or less
	Sensation of shock, not painful; individual can let go at will, as muscular control is not lost.	1 to 8 Milliamperes
UNSAFE CURRENT VALUES	Painful shock, individual can let go at will as muscular control is not lost.	8 to 15 Milliamperes
	Painful shock, muscular control of adjacent muscles lost. Cannot let go.	15 to 20 Milliamperes
	Painful, severe muscular contractions, breathing is difficult.	20 to 50 Milliamperes
	VENTRICULAR FIBRILLATION (A heart condition that results in instant death - no known remedy)	100 to 200 Milliamperes
	Severe burns, severe muscular contractions - so severe that chest muscles clamp heart and stop it during duration of shock. (This prevents ventricular fibrillation)	200 and over Milliamperes

\* 1 Milliampere is one one-thousandth of an ampere